

Earth Syst. Sci. Data Discuss., referee comment RC2  
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## **Comment on essd-2021-166**

Tom Bruulsema (Referee)

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Referee comment on "Global patterns and drivers of soil total phosphorus concentration"  
by Xianjin He et al., Earth Syst. Sci. Data Discuss.,  
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Review of ESSD paper

Global patterns and drivers of soil total phosphorus concentration  
Xinajin Hu et al

Overall this is a well-written paper describing a dataset that may be useful for many purposes. While it is clear that the data were derived from semi-natural sites, the information may be relevant to agricultural issues as well, provided there is clarity on what is represented by the global totals presented.

I offer the following comments and suggestions for improvement of the clarity and interpretation of the paper and dataset.

Line 15 - The term "reserves" has a specific definition applying to the mining of geological phosphate rock resources. I would suggest the word "stocks" be substituted for the word "reserves" as is done in line 26.

Line 15 & 32 - Apparently, P in geological formations and rock below the land surface are not considered. The reference Zhang et al. 2021 in line 32 pertains only to China, and compares soil P only to that in leaves, woody stems, roots, and litter in forest, shrubland and grassland ecosystems. It does not assess geological P. Suggested alternate wording: "In terrestrial ecosystems to a depth of one meter from the land surface, most of the P is found in the soil."

Line 26 (and lines 243-244) - Clarity needs to be provided for these figures on global soil P stocks. Do they include agricultural lands that were not included in the study? If so, do they represent and estimate of the soil total P content prior to land conversion? What percentage of the total would be comprised of such lands? From global fertilizer consumption figures, it can be estimated that ~0.9 Pg of mined P has been added to soils since the early days of fertilizer manufacturing around, and similar figures for the removal of P in crop harvests could be calculated. Such figures would be useful for those concerned about the depletion of soil P relative to the global reserves of phosphate rock (estimated at ~7 Pg P in USGS Mineral Surveys).

Line 34 - Regarding "soil P form depends on the amount or total concentration of P in soils" — This dependence does not seem clear or intuitive, and is not clearly supported by the three references. In fact Turner and Engelbrecht conclude "We conclude that soil properties exert a strong control on the amounts and forms of soil organic phosphorus in tropical rain forests, but that the proportion of the total phosphorus in organic forms is relatively insensitive to variation in climate and soil properties."

Lines 45-48 - the importance of bioavailable soil P relative to total soil P to ecosystem functioning should be discussed.

Line 63 - the two references, Carpenter and Bennett 2011 and Steffen et al 2015 do not support the reliance on accurate soil P maps.

Line 92 - "heavily" should be "heavy"

Line 99 - "potentially useful" should be better defined. What factors decided the exclusion of 77% of the papers?

Line 121-124 - For the under-represented regions, no exclusion of agricultural land was described. Are these regions then more likely to include land that is not semi-natural?

Line 127-128 - What were the data sources for climate, vegetation, etc?

Line 179-180 - need to state the assumption that cropland in its native state had the same set of relationships as for semi-natural land. The possibility that land with different total P levels, or different total P relationships, should be discussed explicitly.

Line 201 - the reported mean and median values then represent a mix of topsoil and

subsoil values. Since subsoil comprised only 15% of the samples, it has little effect, but the numbers for a single specified depth (topsoil) would be more useful and relevant.

line 239 - in Figure 4 it is clear that many of the predictors have non-linear relationships to soil total P. Does the random forest method account for non-linearity?

Line 295 - "soil P is largely composed of organic P" is contradicted by Turner and Englebrecht 2011 who reported organic was 26% of total P for lowland tropical rain forests. Exceptions include the tundra and boreal sites included in this study. These sites were likely the drivers of the SOC-TP relationship.

Line 312 - Amberger reference missing.